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U.S. COAST GUARD
TESTING and DEVELOPMENT DIVISION

OFFICE OF ENGINEERING WASHINGTON, D.C.

REPORT

FIELD TESTING AND DEVELOPMENT UNIT

REPORT NO. 176

PROJECT CGTD J16/2-3-4

PHOTOELECTRIC ALARM DEVICE FOR ROTATING OPTICAL SYSTEMS

15 OCT 1958

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PHOTOELECTRIC ALARM DEVICE FOR ROTATING OPTICAL SYSTEMS

By

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Curtis Bay, Baltimore 26, Maryland

Date: 15 OCT 1958

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ABSTRACT

Tests were conducted on a Model 1001 type 20DA2 photoelectric control manufactured by the Photoswitch Division of the Electronics Corporation of America, Cambridge, Mass. The photoswitch was tested to determine its suitability as an alarm device to detect the slow down in the speed of rotation or the decrease in luminance of a rotating lighthouse beacon. Tests consisted of the measurements of the maximum value of illuminance at the photoswitch aperture which produced activation of the photoswitch, as a function of exposure time. These tests were performed for several settings of photoswitch sensitivity. In addition, endurance tests were conducted to measure the durability of the photoswitch in simulated lighthouse operation.

From the results of the above described tests, it was concluded:

a) The use of the photoelectric control unit tested under this project as an alarm device for rotating beacons is feasible.

b) A filter would be required at the aperture of the alarm device to reduce the illuminance of the phototube to a practical level.

c) Periodic adjustments of the photoswitch sensitivity could be made to compensate for photocell fatigue. Excessive fatigue could be corrected by replacement of the inexpensive phototube.

FIELD TESTING AND DEVELOPMENT UNIT

PROJECT CGTD J16/2-3-4

PHOTOELECTRIC ALARM DEVICE FOR ROTATING OPTICAL SYSTEMS

I

SCOPE

1. Introduction. This is the fourth in a series of reports of tests of devices for indicating irregularities in the operation of a rotating optical system at a light station.

2. Statement of the Problem. To evaluate a commercial model of a photoelectric control as a possible alarm device for a rotating beacon. The evaluation consisted of:

2.1 The initial performance characteristics of the device.

2.2 Its performance over a prolonged period of operation.

II

AUTHORITY

3. This test was performed by authority of Headquarters (ETD) Memorandum to Commanding Officer, Field Testing & Development Unit dtd 27 December 1954, and 10 June 1955, file CGTD J16/2-3-4.

III

PREVIOUS INVESTIGATIONS OF A SIMILAR NATURE

4. This is the first report of tests of a photoelectric alarm device for rotating beacons. Tests of mechanical alarms were described in Field Testing & Development Unit reports dated 15 February 1955, 4 March 1955, and Report No. 103 of 4 January 1956.

IV

PRESENT INVESTIGATION

5. Description of the Material Under Test. The device tested was a stock issue of a type 20M2, Model 1001 photoelectric control manufactured by the Photoswitch Division, Electronics Corporation of America, Cambridge, Mass. Figure 1 (Page 2) is a photograph of the device.

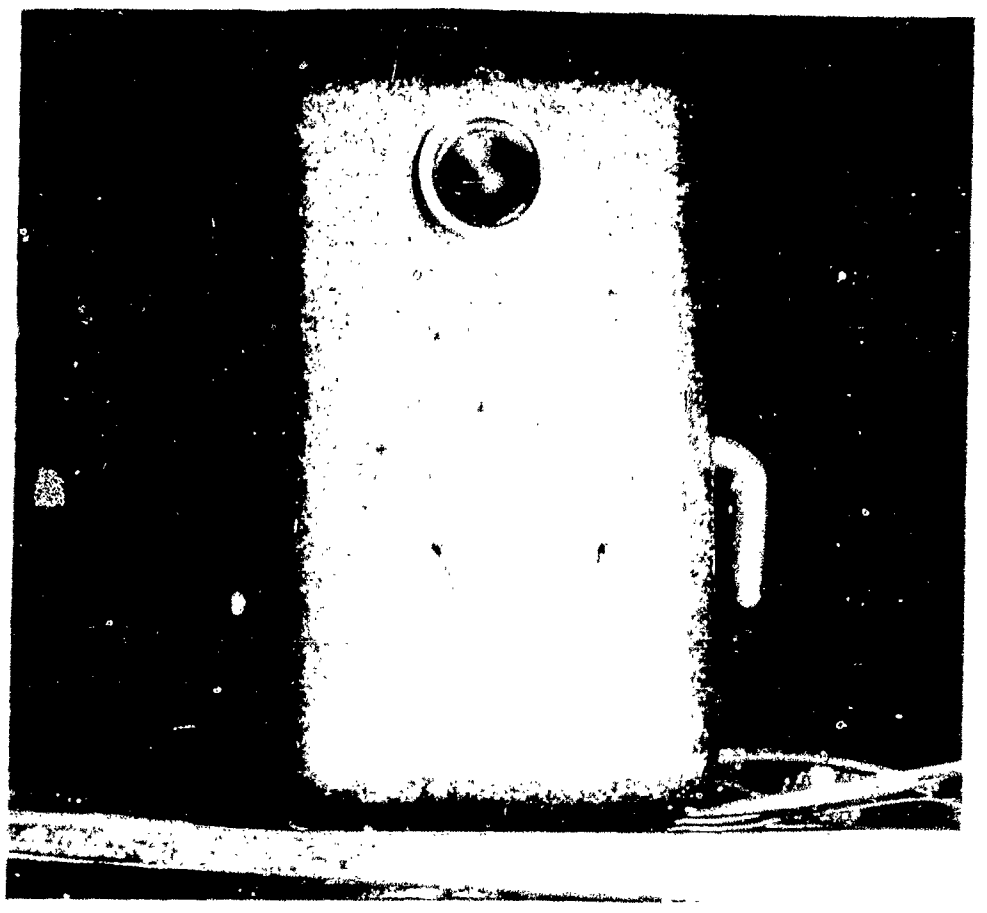

Figure 1
Photoswitch Type 20DA2, Model
1001 Photoelectric Control Device

It consists essentially of a light sensitive, gas-filled phototube (Type 1P40, S-1 response, non-hygroscopic base) and an electronic relay assembled as a package unit whose overall dimensions are 7-7/16" X 4-15/16" X 9-5/8" high. It operates from a 115 or 230 volt, 50/60 cps, power source. The manufacturer's ratings for the unit are as follows.

Power consumption - 15 watts
Illumination level for relay operation (adjustable) - 10 to 50 foot-candles.
Ambient temperature range for proper operation - 32° F to 125° F.
Weight - 15 pounds.

The unit contains heavy-duty, silver, DPDT contacts rated at 10 amperes at 115 volts, or 5 amperes at 230 volts.

6. Description of tests conducted.

6.1 Experimental set-up. The set-up for the first phase of the tests is shown by the schematic of Figure 2 (Page 3). Light from the steady-burning lamp, A, periodically interrupted by the rotating disc, B, with aperture, D, was incident upon the window, E, of the alarm device F. A variable speed motor, C, driving the disc, provided a means of varying the flash period. The load side of the relay within the device was connected to a yellow incandescent lamp, such that, for a given sensitivity setting on the alarm unit, a sufficient decrease in the illuminance of the phototube and/or decrease in speed of rotation of the disc caused this lamp to be lighted.

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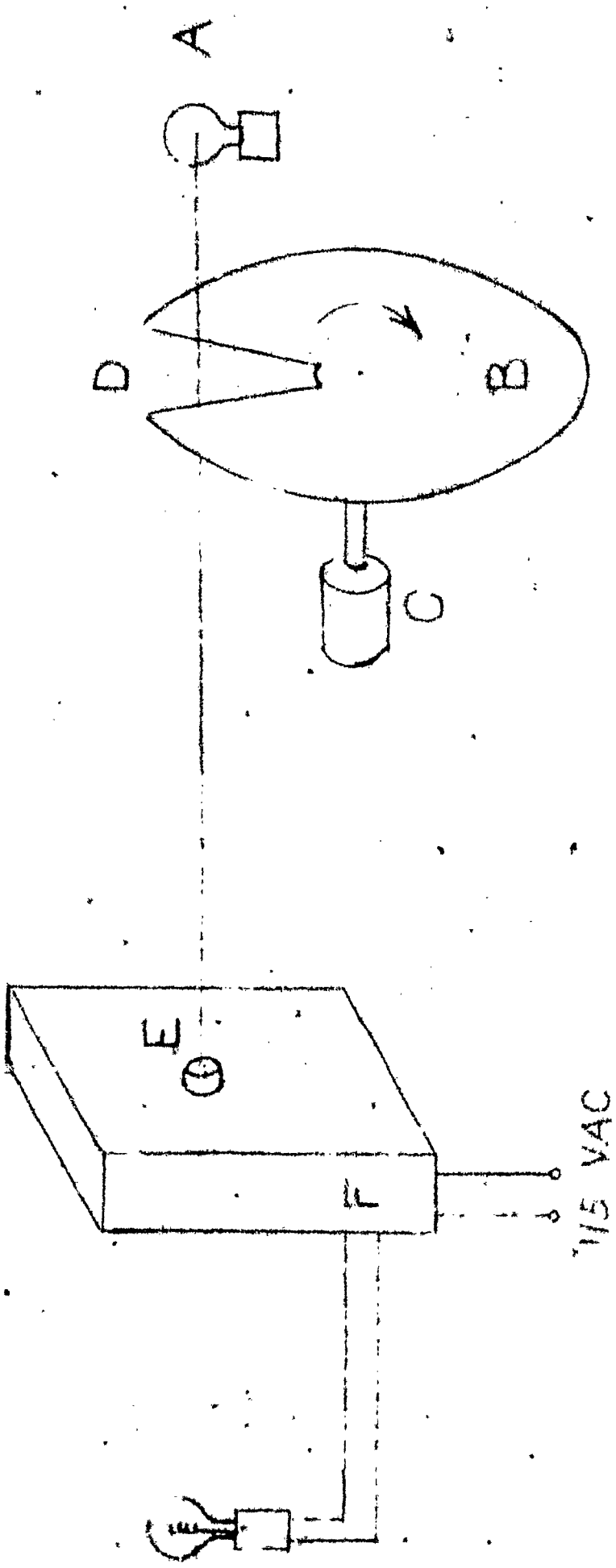

TEST SET-UP FOR PHOTOELECTRIC ALARM CALIBRATION

FIGURE 2.

FIGURE 2.

FIELD TESTING & DEVELOPMENT UNIT COAST GUARD YARD CURTIS BAY, (26) MARYLAND	PROJECT J16/2-3-4	F.T.D.U. SKETCH NO. 174 DATE: 13 OCTOBER 1950 DRAWN BY: J. H. O'S.

6.2 Calibration of Alarm Device. Data for calibration curves were obtained by determining, for each of several speeds of rotation of the disc, the maximum value of illuminance, at the window, for which the alram lamp was energized. This procedure was repeated for each of several positions of the sensitivity adjustment on the device. This sensitivity control, which appears externally as the slotted head of an adjusting screw, was modified by FTDU to permit the addition of a peripheral scale in order that it could be positively returned to any selected setting The ambient level of illumination of the room was determined, and held constant while obtaining the experimental data.

6.3 Endurance Test. Upon completion of the calibration, the equipment was allowed to run without interruption until failure. For this test, the conditions of illuminance and disc speed were set to the values indicated by point (X) on Figure 3. This point was selected as a convenient one in the "knee" of Curve #15, with the illuminance at 8 foot-candles and the period of disc rotation at 2.7 seconds. With this setting, a decrease in illuminance to about 5 foot-candles, or an increase in the period of rotation to about 2.9 seconds, would trigger the alarm.

7. Test Results.

7.1 Calibration Curves. The calibration curves for the alarm device are shown in Figure 3 (Page 5). The parameters on the curves are the arbitrary reference numbers on the scale which FTDU added to the sensitivity adjustment screw.

7.2 Endurance Test. The endurance test was begun on 20 March 1956. During the course of the test, frequent checks were made to insure that the alarm device still functioned properly. These checks usually consisted of reducing the light flux incident on the photocell, although on occasional slowdown of the rotating disc produced an automatic test of the alarm device. The alarm device functioned properly for four months, until the weekend of 20 - 23 July 1956, at which time it failed completely. Reducing the illumination to zero failed to operate the alarm. The device was then returned to the factory for inspection. The failure was found to be the result of a burnedout potentiometer. Enclosure 1 is a copy of an engineering report describing the failure. A new potentiometer was installed, and the reworked unit was again placed on test on 30 September 1957.

7.3 Second Endurance Test. For the second endurance test, the steady-burning lamp and rotating disc were replaced by a 115 volt, 15 watt lamp actuated by a Time-O-Matic timer equipped with a cam cut for a light to dark ratio of 1:5, the timer was set for a flash period of 4 seconds. The illuminance at the window of the alarm device was set at five foot-candles. The test set-up is illustrated in Figure 4 (Page 6).

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TEST OF A PHOTOELECTRIC ALARM

FIGURE 3: CALIBRATION OF SENSITIVITY CONTROL MODEL 20 DAZ

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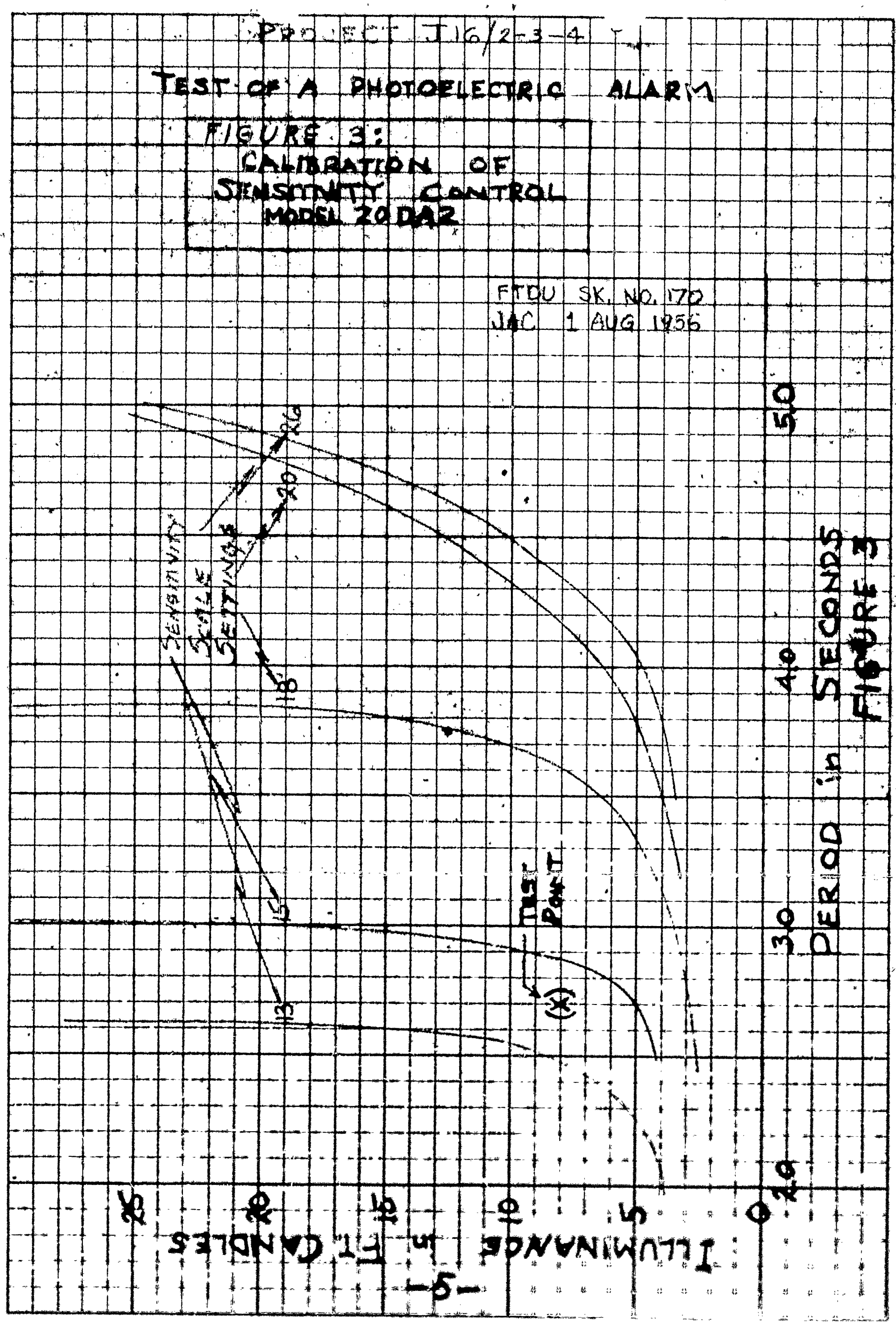

FIGURE 3

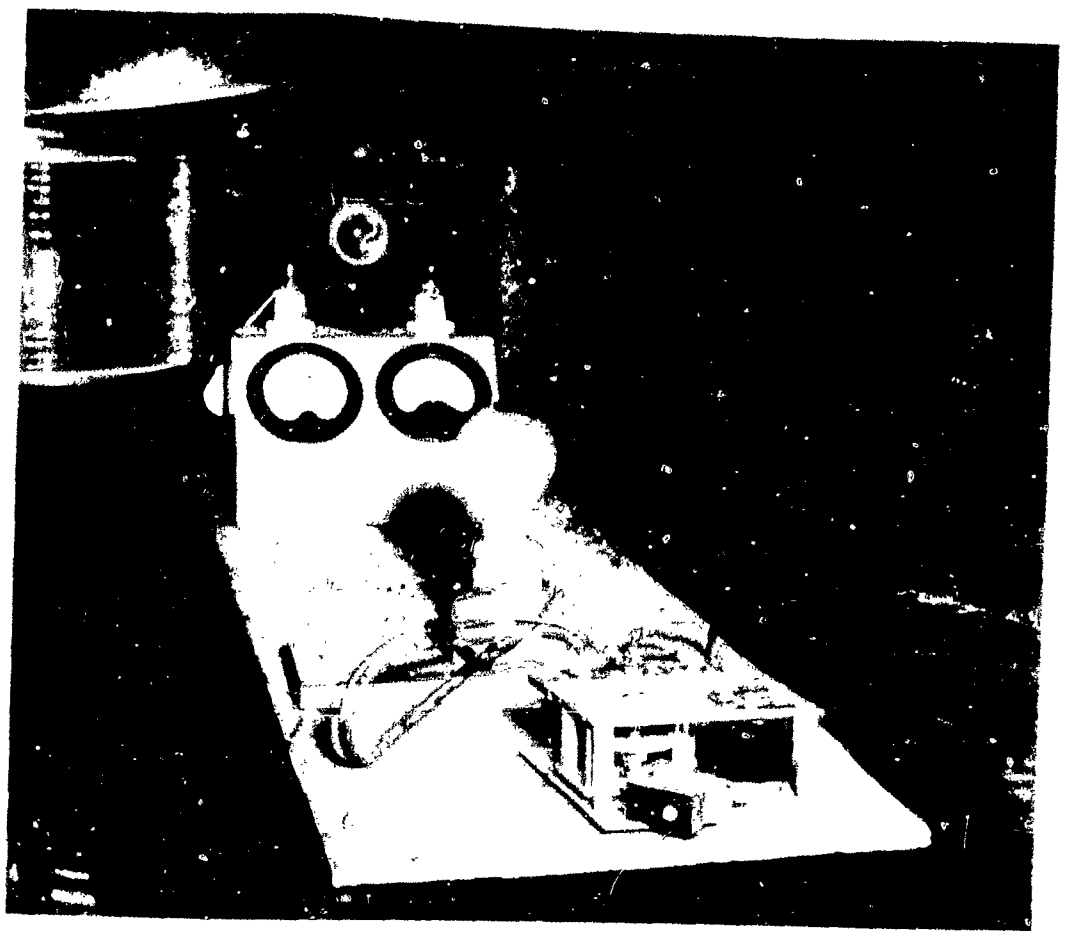

Figure 4
Test Set-up for Second Endurance
Test of the Photoelectric Alarm Device

The scale originally added to the sensitivity adjustment was removed when the alarm device was returned to the factory for repair. The arbitrary sensitivity settings used in the calibration shown by Figure 3 could no longer be repeated. At the start of the second endurance test, the sensitivity adjustment was set to an arbitrary position near the mid point of the range of adjustment. The second endurance test was begun on 30 September 1957. Periodic checks were made, in the manner of the first endurance test, to insure that the device was functioning correctly. On 2 January 1958, the photoelectric alarm unit was still operating properly with the original sensitivity setting, flasher characteristic, and illuminance. Subsequent to that date, it became necessary to increase, periodically, the sensitivity of the control device, by means of the slotted screw adjustment, to maintain satisfactory operation. After reaching the point of maximum sensitivity it was further necessary to increase, periodically, the illuminance of the window of the alarm unit. By mid-September 1958, with the device set for maximum sensitivity, and with a window illuminance of 25 foot-candles, the condition of the device was such that the alarm lamps were energized near the end of the dark period of each cycle. The apparatus was allowed to run in this condition until 1 October 1958. On this date the apparatus was turned off. It was noted, however, that at this time the period of the one second duration flashing source lamp had increased to 6 seconds. On 6 October 1958, the test apparatus was again placed in operation. The flash period and window illuminance were reset to

the original values of four seconds and 5 foot-candles respectively. Under these conditions, the alarm device operated satisfactorily with the sensitivity set somewhat below the maximum available.

8. Discussion of Results.

8.1 The calibration curves of Figure 3 indicate, in general, the range of illuminance and flash periods over which the tested alarm device operates satisfactorily in a new condition. It should be noted, however, that these curves apply to a specific light to dark ratio, which was not recorded when the data were taken.

8.2 The results of the second endurance test are such that it can not be accurately determined how much of the apparent fatigue of the photocell in the device was actual fatigue, and how much was due to the slowdown of the flasher. The fact that the device operated properly, when, at the end of the test, the illuminance and flash period were restored to original values leads to the conclusion that much of the apparent fatigue was caused by flasher slowdown. In considering this conclusion, however, it should be noted that:

(a) In the second endurance test there was no scale provided on the sensitivity adjustment, and the difference between the initial and final sensitivity settings are not known, and

(b) The photocell was not in operation for five days prior to the restoration of the initial illuminance condition and flasher characteristic, and may have recovered to some extent from whatever fatigue it may have experienced.

V

CONCLUSIONS

9.1 The use of the photoelectric control unit tested under this project as an alarm device for rotating beacons is feasible.

9.2 A filter would be required at the window of the alarm device to reduce the illuminance of the phototube to a practical level.

9.3 Periodic adjustments of the sensitivity of the device could be made to compensate for photocell fatigue. Excessive fatigue could be corrected by replacement of the inexpensive phototube.

ELECTRONICS CORPORATION OF AMERICA

September [illegible], 1956

Subject: 20DA2 Control for U. S. Coast Guard

The 20DA2 control was received from U. S. Coast Guard and tested. These are the results:

1. The capacitor across the relay coil was found to be physically damaged (the paper shell was punctured by transformer lamination screw and, therefore, the capacitor was electrically shorted.) This could happen only by removing the unit from the housing, and compressing the chassis so that the transformer screw penetrated the capacitor shell. It seems that this was not the cause of failure at the life test, but was done during the visual inspection at the Coast Guard after the life test. The engineering changes are made changing the transformer screw assembly in order to prevent this sort of damage of the components in the future.

2. The time delay potentiometer was found to be open.

   The opening of the time delay potentiometer was detected on some other units some time ago. The test shows that this was due to over loading the potentiometer at the low end of time delay range. The time delay circuit was redesigned and is already in effect for new production units. Also in the new circuit the time delay is stabilized for temperature changes.

The unit has been reworked and shipped back to Mr. Edward M. Frost, Jr. in Baltimore.

H. V. Dikinis

ENCLOSURE 1